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ABSTRACT

In 1991, a study was conducted by Oakland Community College (OCC) to evaluate the need for a proposed plastics and composites technology program for design engineers. General information was obtained through a literature search, from the Society of the Plastics Industry, Inc., the Michigan Employment Security Commission, and interviews with professionals in the field. In addition, 100 local companies were surveyed, yielding a response rate of 35%. Major findings included the following: (1) design engineers were needed in most areas of the plastics and composites industry; (2) mechanical engineers with no knowledge of plastics were currently being hired due to the lack of design engineers; (3) other local associate degree or certificate programs in plastics and composites technology concentrated on process or manufacturing applications rather than on design; (4) employment opportunities for minorities, women and the handicapped were good due to their current underrepresentation and the federal Targeted Jobs Tax Credit incentive for employers; (5) the total cost for setting up a low-technology plastics laboratory would be \$100,000, with a well equipped laboratory costing approximately \$1,000,000; and (6) based on survey responses from local employers, the average entry level salary for design engineers who hold an associate degree was \$26,300. Appendixes provide a variety of materials on the proposed program, including a mission statement, an outline of goals, a list of courses, brief course descriptions, a list of review committee members, and the survey instrument. (JSP)

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OAKLAND COMMUNITY COLLEGE

PLASTICS & COMPOSITES TECHNOLOGY NEEDS ASSESSMENT

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The Office of Institutional Planning & Analysis

November 1991

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OAKLAND COMMUNITY COLLEGE
PLASTICS & COMPOSITES TECHNOLOGY
NEEDS ASSESSMENT

EXECUTIVE SUMMARY

- Research indicates that the proposed Plastics & Composites Technology program, with an emphasis in design, is in need in Southeast Michigan.
- The future prospects of growth in the Plastics & Composites industry in Michigan are immense. Although the type of technology assistance needed (i.e., employment) will depend on the direction of growth, but *Design Engineers* will be needed in virtually all areas of the industry. Because of the lack of available *Design Engineers* in Plastics & Composites, mechanical engineers with no knowledge of plastics are being hired and trained to do the job.
- Institutions within and around Oakland County that offer Plastics programs at the Associate Degree or Certificate level are not meant to produce *Design Engineers*. Most of them concentrate on process, or manufacturing applications.
- Employment opportunities for minorities such as, women, and the handicapped are also great at this time because of their negligible percentage in the field, and because of Targeted Jobs Tax Credit incentive offered by the federal government.
- Although advancement opportunities in Michigan will vary according to the growth of the industry; the major advantage here is in the presence of hundreds of shops within a radius of seventy five (75) miles, offering specialized capabilities in tooling, custom molding, prototyping, testing, engineering analysis, and design.
- According to a conservative estimate by the Chairman of the Plastics Department at the University of Detroit and the Coordinator of the Post-Degree program in Plastics at Wayne State University, the total cost for a low technology laboratory is \$100,000.

OAKLAND COMMUNITY COLLEGE
PLASTICS & COMPOSITE TECHNOLOGY
PROGRAM NEEDS ASSESSMENT

INTRODUCTION

This report was prepared for the purpose of critically evaluating the proposed Plastics & Composites Technology program. The aim was to determine whether the program would benefit the community and students, while catering to the needs of the Plastics & Composites industry in particular, and other businesses in general. Many institutions around metropolitan Detroit offer programs and courses at various levels in Plastics engineering which focus on process or manufacturing, while the proposed OCC program is geared toward *Design Engineers* in Plastics & Composites at the Associate Degree level.

Background Information

The production and use of plastic composites has increased immensely over the past years, and it seems it will continue to grow. Plastics can be used in various applications where they usually outperform other materials. Because of their versatility and adaptability, the volume of plastics produced now far surpasses the volume of metals.

"Because of the growth and development of plastics, there are outstanding career opportunities for engineers in the field", says Mr. Gulam, a senior engineer in plastics at General Motors. The same opinion is shared by Dr. Thomas Hamade, acting chairman in plastics at the University of Detroit.

Plastics engineers formulate plastics, based on specific performance criteria and fabricate products of various shapes and sizes. They also develop uses, manufacturing processes, equipment and a wide range of related activities, such as selecting appropriate resin for a specific application, design a product, or mold and choose a processing method to shape plastics to product specification. In addition, they provide the vital connection between technician, craftsman, operator and Engineer/Research and Development Scientist, in the operation of a successful plastics processing facility.

Graduates with an Associate Degree in Plastics & Composites Technology initially work under the supervision of a Polymer Engineer/Research Scientist. According to an industry survey (conducted by Oakland Community College), a person with an

Associate Degree in Plastics and Composites Technology may be employed in areas such as Design, Manufacturing, Quality Assurance, Research and Development, Material Testing Laboratory or Programming in CAD, CAM, CIM, or CNC. Survey findings also indicate that with enough experience students may even work as a plant supervisor, project manager, or a junior project engineer.

Initiation Of The Proposed Program

The Plastics and Composites Technology program was initially proposed by Dr. Bill J. Rose (Dean of Academic Services). Preliminary investigative work was done by Dr. Rose, Barbara Einhardt and others. Information was gathered over a two year period which resulted in a program Mission and Goals statement, and curriculum (see Appendix A, and Appendix B).

According to Dr. Rose two points need to be emphasized about the proposed program. First, the importance of establishing industrial partnerships, and second the program is designed to compliment the program at Macomb Community College. In addition, the program is also proposed to be articulated for transfer to a four year program.

Description Of The Proposed Program

There are several Associate Degree programs in plastics currently available at institutions in Michigan. However, none focus on Design Engineering.

The proposed OCC program encompasses design and processing courses as major requirements. In the area of supportive courses it includes technical writing, math, chemistry, physics, drawing, engineering mechanics, CAD, CAM, and management courses. The general education courses include communications, fine arts, social science, and physical education.

Commenting on the proposed curriculum for the Plastics program at OCC, Mr. Gulam, a senior engineer from the plastics division at General Motors, said "Not only does the curriculum at OCC prepare students as design engineers, it provides the knowledge to function in the industry as a Structural Analyst and Manufacturing or Processing Technologist. Students will be able to acquire jobs in automotive as well as in allied industries."

Description Of The Occupation/Industry

The use of plastic materials has become almost universal and because of the demand for plastics, the need for individuals who are competent in design, engineering and implementation of products

made with plastics continues to grow. In order to meet the needs of modern society and to remain technologically competitive, many industries have initiated major opportunities for engineers with a background in plastics/polymers.

All of the specialists interviewed, agree that plastics will replace metals in products such as dinnerware, washing machines, pumps, pipes, writing pens, clothing, shoes, electronics, computers, spacecraft, aircraft, construction, furniture, housewares, packaging, recreational products, toys, and in automobile parts such as instrument panels, and doors.

Plastics & Composites Industry in Michigan: An indication of the status of the plastics industry and its growth in Michigan is evident in the following citation from Automotive News.

"Plastic products and the replacement of existing materials with plastics have grown at a tremendous rate (for items ranging from bicycles wheels to automotive panels). Since 1983, plastic compounders have developed approximately one thousand new materials each year. The automotive industry alone is projected to increase its use of plastics by 50% within the next decade. Trained individuals will be needed to adapt these materials to product design and manufacturing."

Plastics is entering an era of dramatic growth based on the increasing use of new materials in manufacturing, building and packaging.

A recent industry forecast in *Plastics World* (a major trade publication) projected a 12% annual growth rate in automotive parts in to the 1990's, with plastics being substituted for an ever wider range of interior, exterior and under the hood components. Furthermore, Michigan is considered as the haven of the plastics industry.

"For companies in the plastics industry in Michigan today, expansion is the name of the game. Manufacturers in all sectors of the diverse and rapidly growing plastics field say they find the support in Michigan."

Automotive industry in Michigan: The great use of plastics in the automotive industry is cited in several trade journals.

- "The big three auto makers, Ford, General Motors, and Chrysler are looking to expand their use of reinforced plastics. Composites are seen as a possible replacement for automotive sheet metal parts because of their light weight, strength, noncorrosive properties, greater design flexibility and tooling cost."

An Engineering Society of Detroit article cited the following:

"...a prediction of fundamental change in the use of materials in cars and trucks. ... one of the key automotive happenings in the next decade may come from research done on advanced Plastics Composites."

National Trends in the Plastics & Composites Industry:

According to the Composites Institute, in 1989 total shipments throughout the industry were 2.54 billion pounds and in 1990 they increased to 2.57 billion pounds, registering an increase of 1.3% in 1990. (Figure 1)

1. Aircraft/Airspace/Military: Shipments of composites to this market decreased by 5.1, (38.8 million pounds) due to cutbacks in defense spending and cancellation of expected programs, such as the stealth A-12 and Osprey vertical take off and landing aircraft. But in 1991 shipments are expected to increase by 5.6%, to 41 million pounds.

2. Appliance/Business Equipment: Shipments of composites to this industry are for applications such as computer keyboards, copier housings and food service trays. There was a 0.8% growth, (152.6 million pounds) in 1990, and may increase to 153.2 million pounds (an 0.4% increase) in 1991.

3. Construction: Because of the slowdown in business, composite shipments to this market were 467.6 million pounds in 1990, showing a 0.5% decrease from 1989. In 1991 shipments are expected to decrease an additional 3.3%.

4. Consumer Products: In this sector, composites are used for applications such as basketball backboards and consumer appliances, bicycles etc., shipments of composites rose to 165.5 million pounds (5.0%) in 1990. In 1991 shipments are expected to remain constant.

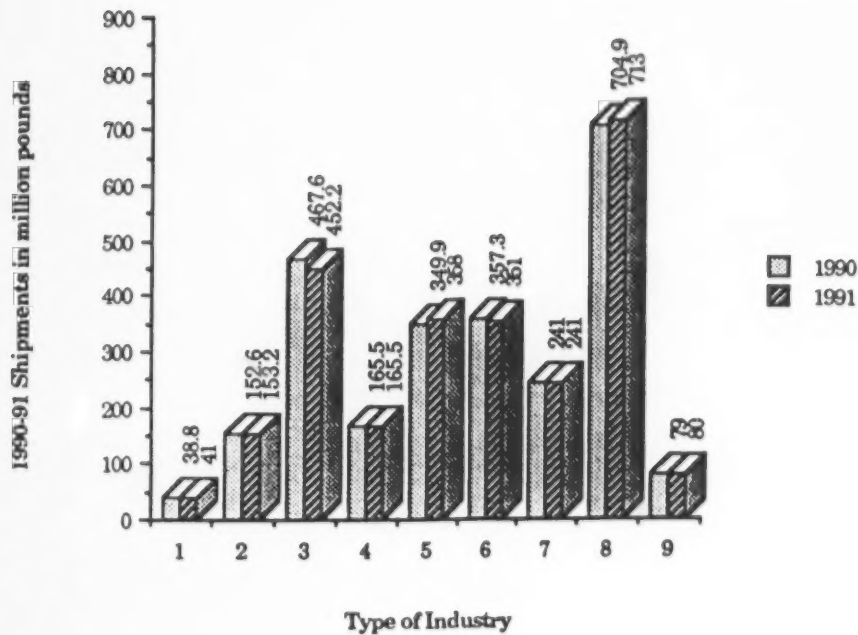
5. Corrosion-Resistant Equipment: Composites are used in the fabrication of items such as pipes, tanks, pollution control equipment, walkways and platforms. In 1990 shipments increased 4.6%, to 349.9 million pounds. In 1991 shipments are expected to increase 2.3%, to 358.0 million pounds. In this market composites continue to replace other material where corrosion resistance, high strength, ease of assembly and long life are required.

6. Marine: Shipments of composites to the marine industry dropped 7.3 in 1990, to 357.3 million pounds. A further drop to 371 million pounds is expected in 1991.

7. Electrical/Electronics: In 1990 shipments to this industry rose to 241.0 million pounds, up 5.1% from 1989. Shipments in 1991 will remain steady.

Trends in Plastics Composites Industry - USA

Fig 1.



TYPE OF INDUSTRY

1. Aircraft/Airspace/Military.
2. Appliance/Business equipment.
3. Construction.
4. Consumer products.
5. Corrosion-Resistant Equipment.
6. Marine.
7. Electrical /Electronics.
8. Transportation.
9. Other.

Source: Composites Institute data (Dec 1990)

8. Transportation: Shipments to this industry increased 4.1% in 1990, to 740.9 million pounds. In 1991 shipments are expected to increase to a total of 713 million pounds, an increase of 1.2%. Composites are used to make auto-body panels, structural components, heavy truck hoods and cabs, and parts for mass-transit equipment, among others. Shipments to this market have been strong because of increased use of composites in cars.

9. Other: Other products using composites include medical equipment, orthopedic appliances, and dental materials. Shipments to this market increased 3.8% in 1990, to 79.0 million pounds. Shipments may increase to 80 million pounds in 1991.

Relation of Proposed Program to College Mission

The production and use of plastics has become almost universal and because of the demand for plastics, the need for individuals who are competent in design engineering and implementation of products made with plastics continues to grow. Plastics are generally regarded as high quality materials which can be tailored for a variety of applications in which they are better than other materials because of their versatility and performance.

Keeping this in view, the proposed Plastics & Composites Technology program is well in line with the college's mission which states:

"The primary mission is Human Development achieved by quality learning opportunities and other services designed to meet the present and emerging educational needs of the communities it serves within the human and physical resources available."

The mission statement of the proposed Plastics & Composites Technology program states:

"A comprehensive Plastics & Composites Technology Program (planned in connection with plastic compounders) is required in the center of the automotive design area (i.e., southern Michigan with its large number of plastic suppliers). Students will utilize the extensive computer capabilities on the Auburn Hills Campus as well as laboratories at various sponsoring industrial development partners. Industrial partners will be selected on the basis of their capacity to offer the latest plastics technology facilities, equipment and resources to the Oakland Community College student."

METHODOLOGY

Methods Of Data Collection

A literature search was performed in order to gain background information. Pertinent information not available in the literature was sought from the Society of the Plastics Industry, Inc. and data from the Michigan Employment Security Commission (MESC).

Experts in the field such as senior engineers at General Motors, private consultants and professors associated with plastics/polymer programs at Wayne State University and the University of Detroit were contacted and interviewed. In addition, one hundred local companies in the field of plastics were surveyed (response rate thirty five percent: see Appendix C).

ANALYSIS

Employment

Career opportunities: Plastics technologists are involved in a broad spectrum of activities including formulation, mold design, management of production facilities, process development, and many others.

A professor in plastics engineering, at the University of Detroit, Dr. Thomas Hamade spoke very highly of the plastics industry. He had the opinion that "the Plastics industry although in its infancy is a multi-billion dollar business. It will have abundant career opportunities in production, development, management etc."

Dr. K.Y. Simon Ng, a professional engineer and Associate Professor in Chemical engineering at Wayne State University, (who is now coordinating the graduate certificate program in Polymer engineering), also had very high expectations about the future career opportunities in the field.

One of the senior engineers in the Plastics division at General Motors, Mr. Gulam said, "the industry will replace metals in the near future. The plastics industry is sufficiently broad and diverse to provide many varied career opportunities to individuals having appropriate fundamental training and education. Presently at G.M. we are utilizing people as plastics designers with experience in metals only."

Current employment: The survey of local employers sought information on current employment in areas of Design, Application, Processing and Production of Plastic products, including extrusion,

injection molding, thermoforming, blow molding and or compounding. Nearly 83% of companies have personnel employed in the above mentioned categories. Ninety percent of these employees are full-time and the remaining 10% are part-time employees (Table 1, Figure 2a and Figure 2b).

Table 1
Employment
in Design, Processing, and Production
of Plastic Products

	<u>Number</u>	<u>Percent</u>
Employed Full-Time	26	74.3
Employed Part-Time	3	8.6
Does Not Employ	<u>6</u>	<u>17.1</u>
Total	35	100.0

Source: OCC Survey

Michigan Employment Security Commission does not maintain statistics with regard to current employment in the plastics and rubber industry as a separate category.

Future employment: Survey findings indicated that, for a well trained Plastic Designer Technologist with an Associate Degree, there will be a demand of 71 full-time and 16 part-time personnel in the next five years. Twenty-four percent of them are needed in the first year, 40% in the next two years and 36% in 3-5 years (Table 2)

Table 2
Need for Plastic Designer Technologist

<i>Plastic Designer with Associate Degree</i>	Full-time		Part-time	
	Number	Percent	Number	Percent
Within one year	17	23.9	6	37.5
Within two years	28	39.4	8	50.0
Three to five years	<u>26</u>	<u>36.7</u>	<u>2</u>	<u>12.5</u>
Total	71	100.0	16	100.0

Source: OCC Survey

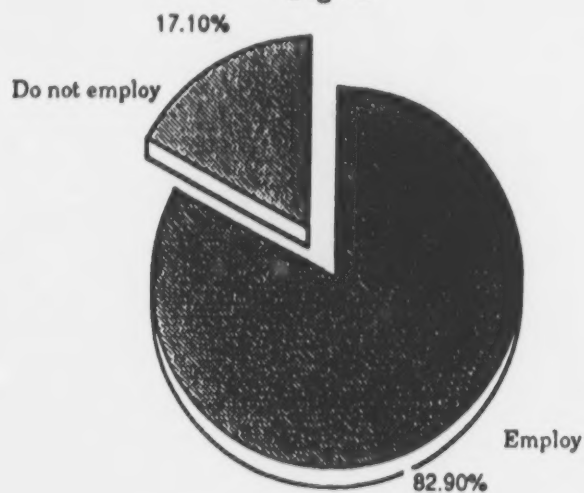
Current employment in Design, Processing and Production (1989)

Respondants= 35

Firms that Employ= 29

Firms that do not employ=6

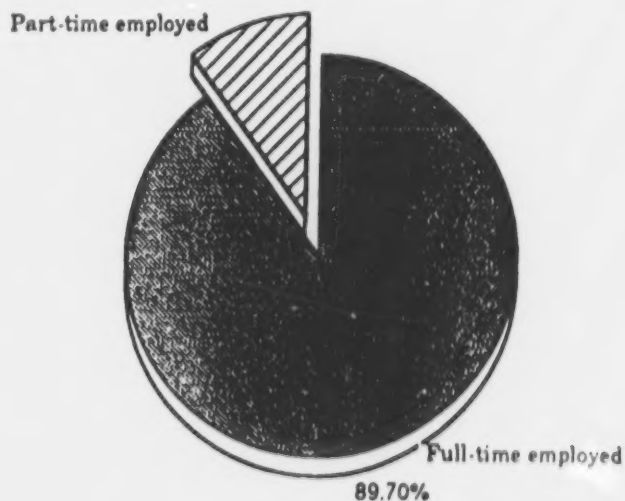
Fig 2a



Full-time employed=26

Part-time employed= 3

Fig 2b.
10.30%



Source: Oakland County Community College Survey Data

Following are MESC projections for a period of 10 years between 1985-1995 in the Chemical and Allied Products and Rubber and Plastics industry (Table 3). This table indicates that in the Plastics and Rubber industry there will be a need of 9,798 more employees by 1995 as compared to 1985, which reflects a change of 22.4%. However, there is expected to be a 2.1% decrease in employment in the Chemical and Allied Products industry.

Table 3
Michigan Industry Projections
(1985-1995)

Industry	1985	1995	% Change
Chemical and Allied Products	40,951	40,100	-2.1
Rubber and Plastics	43,802	53,600	22.4

Source: Michigan Employment Security Commission

Demand for replacement employees: Survey findings also indicate that 28% of personnel leave their job within two years. Sixty-four percent (64%) leave within a period of five years and 80% leave within ten years of their service.

Demand for new employees: Table 2 indicates that, according to the survey of local employers, there will be a demand of 71 new full-time employees and 16 new part-time employees over the next five years. This is an indicator of growth in the Plastics and Composites industry.

Demand for retraining of current employees: Approximately, 33% of respondents plan to retrain their existing staff for the position of Plastic Designer. Sixteen percent (16%) of them would like to hire an external agency to train their existing staff. Fifty-one percent (51%) indicated that they plant to hire trained personnel.

Employee Benefits

Wage and salary: The survey of local employers indicates that the approximate entry-level salary for individuals without formal training is \$8,320 - \$29,120 annually. The approximate entry-level salary for those with an Associate Degree in Plastics Technology varies considerable. Three respondents offer \$15,000 - \$20,000 per year. Twelve offer between \$20,000 and \$25,000, three between \$25,000 and \$30,000 and five offer more than \$30,000 per year. Hence, average salary paid for formally trained individuals is \$26,300 per year (Table 4).

Table 4

	Wage and Salary	# of Respondents
	Annual Salary Range	
No Formal Training	\$ 8,320 - 29,120	35
Associates Degree	\$15,000 - 20,000	3
	\$20,000 - 25,000	12
	\$25,000 - 30,000	3
	\$30,000 and over	5

Source: OCC Survey

Advancement opportunities: Advancement opportunities in Michigan will vary depending on future growth of the industry. According to Bill Rist of General Electric, Michigan is the leader in engineered plastics.

From 1976 to 1986 the number of plastics products firms increased by 52% as reported by the MESCC, the number of jobs in the same interval of time increased from 19,903 to 36,454 which is an increase of 83%.

In 1976-1986 General Electric, DuPont, Dow, Celanese Engineering Resins, Arco Chemical, Monsanto, Borg-Warner and Shell Chemical established plastic application centers in Michigan. These centers focus on design, engineering and production services to their customers in plastics product fabrication.

Robert J. Dereman, director of Dow's Materials Engineering center said that "a major advantage in Michigan is the presence within a 75 mile radius of Detroit of literally hundreds of shops, offering specialized capabilities in tooling, design, prototyping, custom molding, testing and engineering analysis."

Opportunities for the handicapped and minorities: According to MESCC Job Service representative Mr. Frank Boucher, credit is given to employers by the federal government under the Targeted Jobs Tax Credit (TJTC) program if they hire targeted groups such as handicapped, economically disadvantaged, veterans and those who receive ADC or general assistance. According to Mr. Gulam (General Motors), minorities stand a good chance at this point in time because of their current negligible percentage in the field.

Occupation

Level of training needed: According to Mr. Gulam (General Motors):

"Usually we train people for the position of design engineers. At the Associate degree level, even at the undergraduate level design engineers are not available in plastics, only process and manufacturing engineering graduates are available. We have designers who have no knowledge of plastics, and plastics processing people with no knowledge of design. We need designers who are well versed in plastics."

Adequacy of currently available training: Commenting on the OCC program, Mr. Gulam said "Students at other institutions are trained for plastics manufacturing, but the program proposed at OCC will produce design engineers with training in plastics processing. Industry needs this kind of program."

In the state of Michigan there are at least seven (7) Universities and at least three (3) Colleges and one technical center that offer courses in plastics and related fields. Following is a brief description of these programs.

Macomb Community College (Plastics Technology program): Macomb offers a certificate and associate degree in plastic engineering. The curriculum provides student with the training necessary to find employment in either manufacturing and processing of plastics or in the quality control and materials usage or selection. The program is geared to develop knowledge on different plastics materials, processing techniques, tooling and applications, design criteria, various manufacturing processes and be able to utilize testing and measuring equipment to determine properties and make decisions about the various plastic materials, their application and manufacture. Furthermore, the curriculum is intended to provide a qualified work force to the plastic industry by providing knowledge technicians need, to work with engineers and machine operators to develop and produce quality products.

Students can choose any of the specialization pathways of Manufacturing or Material/Quality control. The courses are designed to prepare the student for jobs such as Quality Control Technician, Foreman, Supervisor, Power Supplier, Laboratory Technician etc.

Enrollment in the program is mainly from the work force in plastics or related fields. Not all students join the program to obtain a certificate or degree. Most of the students register in job related courses or to get trained in new areas depending on the need of their employer. Only three students graduated from the program as of December 1990.

The program was implemented four (4) years ago with a grant of \$3.5 million from the state of Michigan. The majority of the grant was spent in purchasing sophisticated laboratory equipment such as: Tensile testing machine, MDT indexer, Injection molding machine, Thermoforming machine, Compression molding machine, Differential Scanning Calorimeter, etc.

The University of Detroit: U of D is the only local university that offers a B.S, M.S and Ph.D in Chemical and Plastics engineering. The B.S in plastics manufacturing technology is a capstone program intended for students who have successfully completed a two year associate's degree program in an appropriate field. Recently the university has started a program in Plastics Technology.

Western Michigan University: Western Michigan's Department of Manufacturing engineering offers options in plastics processing.

Wayne State University: Wayne State's department of Chemical engineering also has a post Associate degree program in Polymer engineering. The undergraduate engineering program at W.S.U includes natural and synthetic rubbers and plastics as one of the majors.

Ferris State University: Ferris offers Associate and Bachelor degree programs in plastic engineering technology.

Eastern Michigan University: Eastern offers undergraduate programs in Polymers and Coatings Technology.

Oakland University: Oakland offers a diploma program in Plastics Technology which is co-sponsored with the Society of Plastics Engineers.

Initial Cost Estimate

For an estimate of the potential cost of equipment, professors at Wayne State University, University of Detroit and plastics engineers at G.M. agreed that it would require approximately one million dollars for a well equipped laboratory, while it will cost \$100,000 for a low technology laboratory. Estimated costs for some typical equipment are provided in Tables 5a and 5b.

Table 5a

Estimated Cost of Equipment

Equipment	Estimated Cost	Course Number
Blow Molding Machine	\$ 70,000	PCT 110, 210
Casting Machine	\$ 30,000	PCT 210, 220
Compression Molding Machine	\$ 30,000	PCT 210, 220
Injection Molding Machine	\$ 50,000	PCT 210, 220
Extrusion Machine	\$ 27,000	PCT 210, 220
Tensile Testing Machine	\$ 18,000	PCT 130
Rheometer	\$ 50,000	PCT 110, 120
Gas Permeation Chromatography	\$ 50,000	PCT 110, 120
Total	\$325,000	

Table 5b

Estimated Cost of Equipment

Software	Estimated Cost	Course Number
1. Software for structural analysis:		
a. Static analysis	\$20,000	CAD 215,216
b. Dynamic analysis software	\$50,000	CAD 215,216
2. Software for design	\$20,000	CAD 215,216
Total	\$90,000	

Those interviewed suggested several methods for reducing the cost of establishing the proposed program:

1. Donations could be sought for machines from the manufacturers.
2. Small lab type machines could be bought, after all college laboratories do not need sophisticated machines.
3. Tap sources such as:
 - a) General Motors may provide access to Design Software. Possible contact person: Mr. Gulam Mohiuddin (Senior Engineer).
 - b) Engineering Analysis and Services Inc. (Auburn Hills), may provide access to software for Structural and design analysis. Contact person Dr. Krishnamoorthi Swamy (President).

SUMMARY

The growth of the plastics industry looks very promising. General opinions of experts in the field indicate that the plastics industry is still in the developing stage and the future for the profession is very bright, with lots of opportunities for advancement.

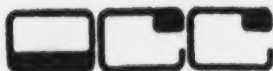
According to survey findings the average entry level salary for design engineers with an Associate degree averages \$26,300.

Most institutions in and around metropolitan Detroit offer courses in chemical, and Polymer engineering, but only a few have a definite program in the area of Plastics Engineering. Colleges and Universities that are offering courses at the Certificate or Associate degree level are designed to produce a qualified work force to the plastics industry by providing knowledgeable technicians mostly in the manufacturing and processing aspects of the field.

Finally, it is estimated that for a low technology laboratory the potential cost in the area of \$100,000 while a well equipped laboratory could cost close to one million dollars.

APPENDIX A

PROPOSED PLASTICS & COMPOSITES TECHNOLOGY PROGRAM MISSIONS AND GOALS STATEMENT/CURRICULUM



FOR DISCUSSION ONLY

WORKING COPY

4/21/89

REVISED:

4/27, 5/4, 5/18, 5/31

PLASTICS COMPOSITES TECHNOLOGY MISSION STATEMENT

Plastic products and the replacement of existing materials with plastics have grown at a tremendous rate (for items ranging from bicycle wheels to automotive panels). Since 1983, plastic compounders have developed approximately 1000 new materials each year. Based on an article in Automotive News, July, 1988, the automotive industry alone is projected to increase its use of plastics by 50% within the next decade. Trained individuals will be needed to adapt these materials to product design and manufacturing.

A comprehensive Plastics Composites Technology Program (planned in connection with plastic compounders) is required in the center of the automotive design area (i.e. southeastern Michigan with its large number of plastic suppliers). Students will utilize the extensive computer capabilities on the Auburn Hills Campus as well as laboratories at various sponsoring industrial development partners. Industrial partners will be selected on the basis of their capacity to offer the latest plastics technology facilities, equipment and resources to the Oakland Community College student.

PLASTICS TECHNOLOGY
GOALS

- 1) Utilizing appropriate computer software techniques, the participant will design consumer/electronic/automotive parts (plastics and/or composites).
- 2) Utilizing appropriate computer software techniques and analytical materials, the participant will be able to complete tests of current and new plastic materials.
- 3) The participant will be able to perform, select, and/or specify methods of processing (i.e. molding) and manufacturing secondary operations (i.e. cutting, trimming, drilling).
- 4) Applying concepts of Computer Integrated Manufacturing, the participant will be able to use project management techniques to direct the entire plastic product development and manufacturing process.
- 5) Utilizing facilities and resources of industrial partnerships at their sites, the student will gain experience in the designing and manufacturing techniques described above.

PLASTICS COMPOSITES TECHNOLOGY
ASSOCIATE DEGREE PROGRAM

MAJOR REQUIREMENTS:

CREDITS

DESIGN:

PCT 110	Polymeric Properties: Mechanical and Processing
PCT 120	Mechanical Behavior of Plastics
PCT 130	Product Process Design
CAD 215	CAD Applications in Product Design
CAD 216	Basic Techniques in Finite Element Modeling and Analysis
CAD 225	Product Design Special Applications I

PROCESSING:

PCT 210	Plastic Manufacturing Processing I
PCT 220	Plastic Manufacturing Processing II
PCT 230	Plastic Processing Simulation
PCT 240	Plant Manufacturing Process Simulation
PCT 250	SPC Principles & Integration Into the Plastic Product Design Process

REQUIRED SUPPORTIVES:

CREDITS

MAT 115	Intermediate Algebra	4
MAT 154	College Algebra	4
MAT 156	Trigonometry	3
CHE 151	General Chemistry I	4
CHE 152	General Chemistry II	4
PHY 161	College Physics I	4
DRT 111	Introduction to Technical Drawing	3

DRT.112	Technical Drawing Applications	3
DRT 116	Applied Descriptive Geometry	3
MEC 201	Engineering Mechanics	3
MEC 202	Mechanics of Materials	3
CAD 110	Intro to Computer Aided Design	3
CAD 120	Computer Aided Design Applications I	3
CAD 130	Computer Aided Design Applications II	3
CAD 210	Three Dimensional Pictorials	3
CIM 110	Intro to Computer Integrated Manufacturing	4
BUS 253	Principles of Management	3

GENERAL EDUCATION:

CREDITS

Communications / English	3
Fine Arts / Humanities	3
Mathematics / Science (<i>fulfilled above</i>)	3
Social Science	3
American Government POL 151	3
Written Communication	3
Physical Education	1

COURSE DESCRIPTIONS MAJOR REQUIREMENTS

PCT 110 Polymeric Properties: Mechanical and Processing
PREREQUISITES: MAT 115, MAT 154, MAT 156, CHE 151, CHE 152, PHY 161

The concepts of thermosetting, thermoplastics, and glass transition temperature will be studied. The behavior of polymeric materials is classified by plastic and/or composite types. Effects of heat, temperature, pressure, loading and environment (including chemical, ultraviolet and ultrasonic) on the properties will be studied. Laboratory work will determine the properties and their changes for product design, manufacturing, handling and recycling use.

PCT 120 Mechanical Behavior of Plastics
PREREQUISITE: PCT 110

Topics of instruction will include aspects of the mechanical properties of plastics including tensile, compressive and shear properties; elastic and flexural moduli; dynamic and fatigue properties; and friction and wear characteristics. Included will be discussions of thermal, electrical and other physical properties applied to products and manufacturing procedures, as well as standard methods of testing to acquire these properties.

PCT 130 Product Process Design
PREREQUISITES: MEC 201, MEC 202

This course will present the basics of mechanical design, as applied to products, with special emphasis on plastic products and the processing aspects. Considered will be the part function, structural considerations, appearance, environment, economic options and manufacturing options.

CAD 215 CAD Applications In Product Design
PREREQUISITE: CAD 210 or consent of instructor

Using a three dimensional computer aided design and drafting system, the student will develop skills and abilities to solve product design and drafting problems. The student will learn the methods of creating various types of curves and surfaces and techniques of smoothing curves. The course will also provide the student with the concepts of advanced solid modeling and design analysis. The newest techniques in processes such as stereolithography for prototype applications will be covered. Students will be assigned projects to compliment their area of specialty. A CAD/CAM system will be used to complete the projects.

**CAD 216 Basic Techniques In Finite Element Modeling
and Analysis**

PREREQUISITE: CAD 215

The computerized techniques to predict the performance of parts and tooling will be studied. Methods of creating the finite element model and the application of proper loads and conditions to simulate the real problem will be presented as well as benefits and limitations. These techniques will be applied to such areas as metallic, plastic, and composite parts in lab sessions to answer the "what if" questions.

CAD 225 Product Design Special Applications I

PREREQUISITE: CAD 216

This class will be a culmination of applications of all the above theories and knowledge to create a unique specific consumer plastic product.

PCT 210 Plastic Manufacturing Processing I

PREREQUISITE: PCT 120

Standard methods of manufacturing metal components for forming plastic parts by various techniques will include:

Blow Molding, Casting, Compression Molding, Extrusion, Injection Molding, Closed Mold Processing, Open Mold Processing, Pultrusion and Pulforming and Rotational Molding.

This instruction will include visits to actual operating facilities, videotapes supplied by equipment and resin manufacturers, and visits to a mold builder and prototype shop.

PCT 220 Plastic Manufacturing Processing II

PREREQUISITE: PCT 130

Specific product type will be discussed along with composites and advanced composites for unique applications including automobiles, aerospace, biomedical and leisure activities. The above processes will be simulated by computer aided techniques. Instruction will include guest speakers with multi-media presentations and visits to participating industries.

PCT 230 Plastic Processing Simulation

PREREQUISITE: PCT 140

This class will be the study of a specific application of advanced computer techniques to simulate the behavior of the material in the mold and/or die cavities before a part or tool is constructed. Variables to be investigated include clamping, pressure, temperature of materials and cavities, and molding and/or injection pressure. Output results will indicate the performance of the tooling, the strength of the part, regions of increased density, defect area location and size, and resultant part shrinkage and distortion during subsequent operation.

PCT 240 Plant Manufacturing Process Simulation

PREREQUISITE: PCT 230

The student will identify and simulate the production of the plastics part and the transfer to other secondary operations concerned with integration into the final process, including coatings, fasteners, adhesives and aspects of shipping. Methods of simulation will include two- and three-dimensional softwares, manufacturing multi-media presentations, and industrial visits.

PCT 250 SPC Principles and Integration into the Plastic Product Design Process

PREREQUISITE: PCT 220

The principles of statistical quality control will be studied as well as techniques for determining the proper values to measure for different plastic products. Techniques to study process variations and trends will be included with corrective actions. Applications and computerized techniques and methods of documenting this information in the CIM process will be discussed.

COURSE DESCRIPTIONS REQUIRED SUPPORTIVES

MAT 115 Intermediate Algebra

PREREQUISITE: MAT 110 or one year of secondary college-prep algebra

Properties of real numbers; review of basic operations with polynomials; factoring; algebraic fractions; synthetic division; exponents, roots and radicals; imaginary and complex numbers; first degree equations and inequalities in one variable; second degree equations and inequalities in one variable; relations and functions and their graphs; distance and slope formulas; different forms of linear equations; quadratic functions and the conic sections; systems of equations and the determinant; exponential and logarithmic functions and their graphs, and computations using the logarithmic table and linear interpolation.

MAT 154 College Algebra

PREREQUISITE: Two years of secondary college-prep algebra or MAT 115

Properties of real numbers; the field axioms; proof of theorems involving the real numbers; review of operations with polynomials, exponents and radicals; linear and quadratic relations and functions, and their graphs; conic sections; the algebra of functions, including composition; inverse functions; exponential and logarithmic functions; solution of equations and systems of equations; theory and use of matrices and determinant; complex numbers and vectors; theory of equations, including the factor, remainder and rational roots theorems; sequences and series; combinatorics, including combination and permutation; induction proofs; binomial theorem.

MAT 156 Trigonometry

PREREQUISITES: Two years of secondary college-prep algebra or MAT 115 and one year of secondary geometry or MAT 114

Basic ideas, including review of sets, relations and functions; definition of the trigonometric functions as circular functions; graphs of the trigonometric functions; development and use of trigonometric identities; solution of trigonometric equations; inverse trigonometric functions; applications; definition of the trigonometric functions in a right triangle; solution of right triangles by trigonometry; solution of non-right triangles by use of law of sines and law of cosines; complex numbers and De Moivre's Theorem.

CHE 151 General Chemistry I

PREREQUISITES: Secondary school chemistry or CHE 100 and two years of secondary school algebra or MAT 115

This course explores the principles of atomic structure, molecular orbital theory, chemical bonding, stoichiometry, acid-base theory, the kinetic molecular theory and solution chemistry. Both conceptual development and problem solving are emphasized. The laboratory section of the course involves application and amplification of the concepts developed in the course.

CHE 152 General Chemistry II

PREREQUISITE: CHE 151

This course explores the principles of kinetics, chemical equilibria, nuclear chemistry, thermochemistry, electrochemistry, coordination chemistry and organic chemistry. Both conceptual development and problem solving are emphasized. The laboratory section of the course involves application and amplification of the concepts developed in the course, including qualitative analysis to illustrate equilibria concepts.

PHY 161 College Physics I

PREREQUISITE: MAT 156 or MAT 163 or consent of instructor

The student will investigate the physical aspects of mechanics, sound and heat. The student will perform measurements and experiments in mechanics, sound and heat.

DRT 111 Introduction to Technical Drawing

PREREQUISITE: None

Students will identify and define the theory of orthogonal projection and pictorial drawing. Using methods of descriptive geometry, they will solve spatial problems employing the geometric elements of points, lines, and planes. They will execute freehand lettering, sketching and instrument drawing.

DRT 112 Technical Drawing Applications

PREREQUISITE: DRT 111 or consent of instructor

Students will make detailed drawings of a variety of parts, based on projection techniques, sectional views, threads and fasteners, dimensioning fundamentals and other conventional drawing practices. In addition, they will design and execute charts and graphs for data display and analysis and practice required instrument skills to produce inked drawings.

DRT 116 Applied Descriptive Geometry
PREREQUISITE: DRT 111 or consent of instructor

Students will use basic orthogonal projection, including auxiliary views to solve problems of true distance, true size, true angles, intersections and developments. They will also use the methods of revolution and cutting planes separately or with auxiliary views to solve typical problems.

MEC 201 Engineering Mechanics
PREREQUISITES: PHY 161, MAT 156 or consent of instructor

The student will identify and define the principles of statics and dynamics by applying the theories to practical problems related to engineering technology.

MEC 202 Mechanics of Materials
PREREQUISITE: MEC 201

The student will identify and define the properties of materials as related to the theories of elasticity, stresses, torsion, strength of beams, joints, connections, and use selected laboratory testing machines.

CAD 110 Introduction to Computer Aided Design
PREREQUISITE: DRT 111 or consent of instructor

This course is an introduction to the field of computer aided drawing and design. It will provide the student with an overview of the use and development of computers as applied to the field of mechanical drawing. The student will learn the software capability of the system by generating, moving, editing, or deleting the basic projection elements. Students will become familiar with CRT, keyboard, tablet/menu, function buttons, and other items that make up the system. In addition to formal classroom lecture, students will have the opportunity to use equipment similar to that found in the drafting room to complete a series of assignments.

CAD 120 Computer Aided Design Applications I
PREREQUISITES: DRT 112 and CAD 110 or consent of the instructor

The student will develop skills and abilities in using the computer's hardware and software to create standard orthographic views. The student will create working detail drawings by adding the necessary sections, dimensions, tolerances, notes, and specifications to the computer generated views.

CAD 130 Computer Aided Design Applications II
PREREQUISITES: CAD 120, DRT 116, or consent of instructor

The student will develop skills in dealing with advanced concepts of computer generated drawings. The student will create two and a half dimensional drawings, merge and split drawing models, perform section analysis, and learn assembly techniques as related to concepts of descriptive geometry.

CAD 210 Three Dimensional Pictorials
PREREQUISITE: CAD 130

The student will develop skills and abilities in using the computer hardware and software to solve three dimensional engineering and drafting problems using Computer Aided Engineering (CAE) techniques. The student will create three dimensional wireframe and solid models. This course will also provide the student with the basic concepts of surface development.

CIM 110 Introduction to Computer Integrated Manufacturing
PREREQUISITE: None

The student will develop an understanding of CIM systems as they relate to the integration of automatic segments of manufacturing processes for use in product design, production planning control, production equipment, production processes, quality assurance, packaging and shipping. The total concept of the automated factory, its development and implementation will be explored.

BUS 253 Principles of Management
PREREQUISITE: BUS 101

Students will develop managerial skills relative to planning, organizing, activating and controlling business organizations. They will utilize these concepts of management as a process in marketing, production, finance, personnel and office management.

APPENDIX B

REVIEW COMMITTEE

PLASTICS COMPOSITES TECHNOLOGY REVIEW COMMITTEE

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Oakland Community College

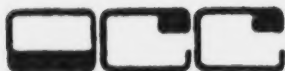
Barbara Einhardt

Dr. Bill J. Rose

Ray Sands

Dr. Carol F. Stencel

APPENDIX C



OAKLAND COMMUNITY COLLEGE

AUBURN HILLS CAMPUS • 2900 FEATHERSTONE ROAD • AUBURN HILLS, MICHIGAN 48057 • 313-853-4200

SURVEY INSTRUMENT

PLASTICS COMPOSITES TECHNOLOGY

NEEDS ASSESSMENT

The Auburn Hills Campus of Oakland Community College is currently developing a new Associate Degree Program in Plastics Composites Technology.

The program is designed to prepare graduates to accomplish the following goals:

1. Utilizing appropriate computer software techniques, the participant will design consumer/electronic/automotive parts(plastics and/or composites).
2. Utilizing appropriate computer software techniques and analytical materials, the participant will be able to complete tests of current and new plastic materials.
3. The participant will be able to perform, select, and/or specify methods of processing (i.e. molding) and manufacturing secondary operations (i.e. cutting, trimming, drilling).
4. Applying concepts of Computer Integrated Manufacturing, the participant will be able to use project management techniques to direct the entire plastic product development and manufacturing process.
5. Utilizing facilities and resources of industrial partnerships at their sites, the student will gain experience in the designing and manufacturing techniques described above.

Please help us determine the need for graduates with an Associate Degree in Plastics Composites Technology in Oakland County and the Southeastern area of Michigan by completing the attached survey.

Please return in the enclosed envelope to Oakland Community College. If you have questions or comments, please contact:

Dr. Bill Rose
Dean of Career Education
Oakland Community College
2900 Featherstone Road
Auburn Hills, MI 48057
313-853-4312

1. Do you currently employ persons in the design, application, processing and production of plastic products, including extrusion, injection molding, thermoforming, blow molding and/or compounding?

_____ Yes

_____ Full-time employees

_____ Part-time employees

_____ No

2. What is the educational background of the Plastic Designer Technologists whom you employ? (Please indicate the approximate number at each level.)

_____ Non-high school graduate with on-the-job training

_____ High school graduate with on-the-job training

_____ Some college with on-the-job training

_____ Associate Degree in Plastics Technology

_____ Bachelor's Degree in Engineering or related degree

_____ Other

3. At the time of employment, do graduates of Plastics Technology Programs receive higher salaries than non-graduates?

_____ Yes

_____ No

4. What is the approximate entry-level salary for those without formal training?

_____ Hourly wage or

_____ Yearly salary

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5. What is the approximate entry-level salary for those with an Associate Degree in Plastics Technology?

☐ \$10,000 - \$15,000
☐ \$15,000 - \$20,000
☐ \$20,000 - \$25,000
☐ \$25,000 - \$30,000
☐ Over \$30,000

6. What is the average length of time that Plastics Designer Technologists remain at your company?

☐ Less than one year
☐ One year
☐ Two years
☐ Three - five years
☐ Five - ten years
☐ More than ten years

7. If you plan to employ Plastic Designer Technologists at your company within the next five years, would you . . . (Check all that apply.)

☐ Train your existing staff?
☐ Contract with external training at your site?
☐ Contract with external training at their site?
☐ Hire persons already trained?

8. Assuming that well trained Plastic Designer Technologists with Associate Degrees were available for employment, how many would you hire within the indicated time periods?

Full-Time Employees

_____ Within one year
 _____ Two years
 _____ Three - five years

Part-Time Employees

_____ Within one year
 _____ Two years
 _____ Three - five years

9. In what kind of jobs would you assign employees with an Associate Degree in Plastics Composites Technology?

10. Following is a tentative list of course titles for the proposed Associate Degree in Plastics Composites Technology. Please indicate which courses you feel are appropriate or inappropriate for students.

Appropriate

Not Appropriate

_____	Polymeric Properties: Mechanical and Processing	_____
_____	Mechanical Behavior of Plastics	_____
_____	Product Process Design	_____
_____	CAD Applications in Product Design	_____
_____	Basic Techniques in Finite Element Modeling and Analysis	_____
_____	Product Design Special Applications I	_____
_____	Plastic Manufacturing Processing I	_____
_____	Plastic Manufacturing Processing II	_____
_____	Plastic Processing Simulation	_____
_____	Plant Manufacturing Process Simulation	_____

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Appropriate

Not Appropriate

_____	SPC Principles & Integration into the Plastic Product Design Process	_____
_____	Intermediate Algebra	_____
_____	College Algebra	_____
_____	Trigonometry	_____
_____	General Chemistry I	_____
_____	General Chemistry II	_____
_____	College Physics I	_____
_____	Introduction to Technical Drawing	_____
_____	Technical Drawing Applications	_____
_____	Applied Descriptive Geometry	_____
_____	Engineering Mechanics	_____
_____	Mechanics of Materials	_____
_____	Introduction to Computer Aided Design	_____
_____	Computer Aided Design Applications I	_____
_____	Computer Aided Design Applications II	_____
_____	Three Dimensional Pictorials	_____
_____	Introduction to Computer Integrated Manufacturing	_____
_____	Principles of Management	_____

11. Please list any additional courses which you feel should be included.

12. Do you see a need for OCC to offer an Associate Degree in Plastics Composites Technology?

_____ Yes

_____ No

OPTIONAL

Company _____

Address _____

Person Completing _____

Phone _____

REFERENCES

References.

1. Automotive News. July 1988.
2. Engineering Society of Detroit, v2, no 4, Aug/Sep 1989),.
3. Automotive News. April 1989.

References of Personnel.

Mr. Frank Boucher (MESC Job Service, Ph 891-4306)
Mr. Gulam Mohiuddin (Senior engineer G.M, Ph 857-1367)
Mr. Sam Gaft (Professor Macomb College, Ph 445-7489)
Dr. Thomas Hamade (Professor U of D, Ph 855-1958)
Dr. K.Y.Simon Ng (Professor Wayne State University, Ph 577-3805)